NOAA Remotely Operated Aircraft (ROA) Working Group & Steering Committee

Kickoff Meeting – July 18, 2005

LCDR Harris Halverson, NOAA

Staff Assistant to Director, Marine and Aviation Operations Centers and

NOAA ROA “Program” Manager

Ms. Sara Summers – OAR/FSL

Deputy NOAA ROA “Program” Manager

Purpose

- Establish ROA Working Group and Steering Committee – why are we here?
- “Meet & greet” with fellow members
- Overview of what’s happening with NOAA and other agency ROA activities and where we want to go

Outline

- How we got to this meeting - including recommendations from May 4, 2005 NEC
- Introduce Working Group & Steering Committee Members
- Purpose and Mission statements (draft)
- ROA 101 - what's happening with ROA's now?
- Can ROA's fulfill gaps in NOAA requirements?
- NOAA / NASA / GA-ASI Altair demo overview - Sara
- NOAA ROA's in the PPBES process
- Where do we want to go?
- Responsibilities of this group

How we got to today's meeting

- NOAA interest in ROA activities for years, particularly from Dr. Sandy MacDonald at FSL (OAR)
- VADM Lautenbacher's desire to investigate the use of ROA's to fulfill NOAA requirement gaps – a "fan" of ROA's since his days in the Pentagon
- Demonstration with NASA and General Atomics Aeronautical Systems, Inc (GA-ASI) – March thru August '05
- May 4, 2005 NEC Presentation established NOAA ROA Working Group & Steering Committee and direction to have a single NOAA ROA point of contact residing in NMAO HQ's
- Line & Goal Team reps to ROA Working Group & Steering Committee solicited by Director, NMAO – RADM De Bow

Recommendations for NOAA Approved by May 4, 2005 NEC

- Develop a NOAA ROA Working Group and Steering Committee
- Appoint a single point of contact for ROA Activities across NOAA
- Require all NOAA ROA activities be executed through NASA with NASA co-sponsored FAA Certificate of Authorizations (COAs)
- Pursue partnerships with other Federal Agencies with common interests and requirements
- Participate in ROA airspace integration activities

ROA Steering Committee Members

Line Office Reps:

- RADM Richard Behn - NMAO (co-chair)
- Dr. Alexander “Sandy” MacDonald, OAR (co-chair)
- Greg Mandt – NWS
- CAPT Craig Mclean – NOS
- CAPT Gary Petrae – PP&I
- NMFS & NESDIS – no one appointed

Goal Team Reps:

- Dr. Marty Ralph – Weather & Water (?)
- Mike Aslaksen – Commerce & Transportation
- Dr. David Fahey – Climate
- Ecosystems & Support – no one appointed

ROA Working Group Members

Line Office Reps:

- LCDR Harris Halverson - NMAO (Chair)
  - LCDR Randy TeBeest – December ‘05
- Sara Summers, OAR (Deputy)
- Dr. Zoltan Toth / David Helms (alternate) – NWS
- Dr. Richard Merrick – NMFS
- Eric Miller – NESDIS
- Todd Jacobs - NOS
- CDR Todd Stiles – PP&I

Goal Team Reps:

- Jon Sellars – Commerce & Transportation
- Dr. Jim Elkins – Climate
- Ecosystems, Weather & Water, and Support – no one appointed

DoD Observers (as directed by VADM Lautenbacher):

- U.S. Air Force - Colonel Mark Weadon
- U.S. Navy – Mr. Phil Vinson
- NOAA Liaison to Oceanographer of the Navy – CDR Chris Moore

Purpose and Mission Statements (draft)

- Purpose: A formal body to serve as NOAA's focal point for collaboration and information regarding the application of ROA technology in the accomplishment of NOAA missions.
- Mission: To make recommendations to NOAA's leadership on the application of ROA technology to fulfill research and operational data gaps in critical areas, such as weather and water, climate and ecosystem monitoring and management.

Why ROAs?

- **What is a ROA?**
  - ROA is an acronym that is used to reference any unmanned aircraft regardless of its mode of operations (i.e., autonomous, pilot-in-the-loop, etc)
  - The term ROA is synonymous with Unmanned Aerial Vehicle (UAV), Unmanned Aircraft System (UAS) and other terms.
- **Best choice to perform dull, dirty, dangerous tasks**
- **Requirements for civil applications are emerging for ROAs in the U.S. – (AeroVironment brief to VADM on July 12, 2005)**
- **Market pressures provide increased innovation and manufacturing in U.S. aviation industry**

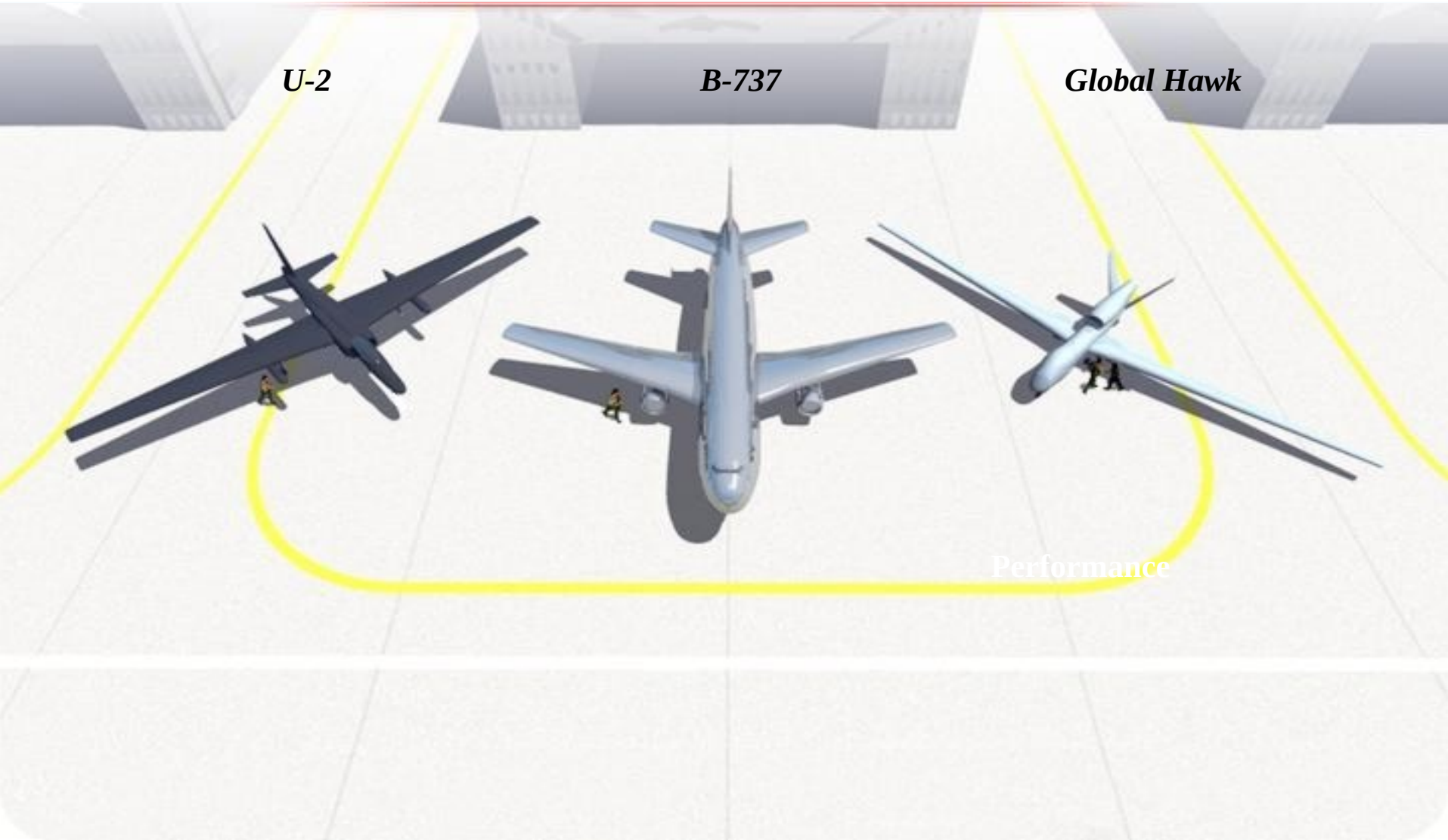
Where are ROAs now?

- Military is primary user; DHS requirements are rapidly developing; civil use to follow
- DoD ROA Roadmap
- Access 5 Program
- UAV National Task Force (UNITE)
- RTCA Special Committee 203

Types of ROAs

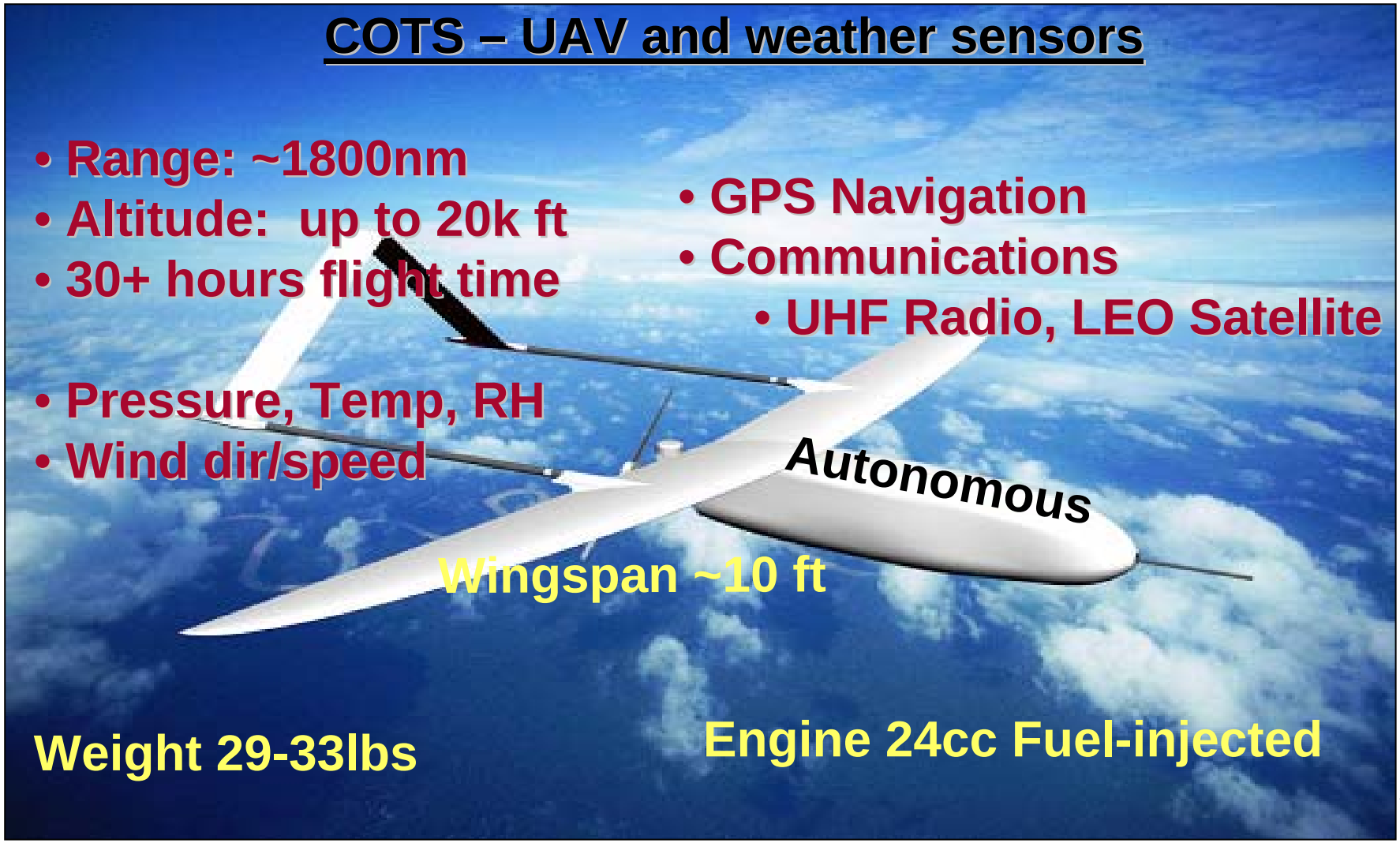
- Endurance - operate at higher altitudes and longer ranges
- Tactical –operate at lower altitudes and within line-of-sight
- Small –man-portable and to operate within a few miles of the control station
- Micro – are hand or smaller sized ROAs (six inches maximum)

Global Hawk Size Comparison



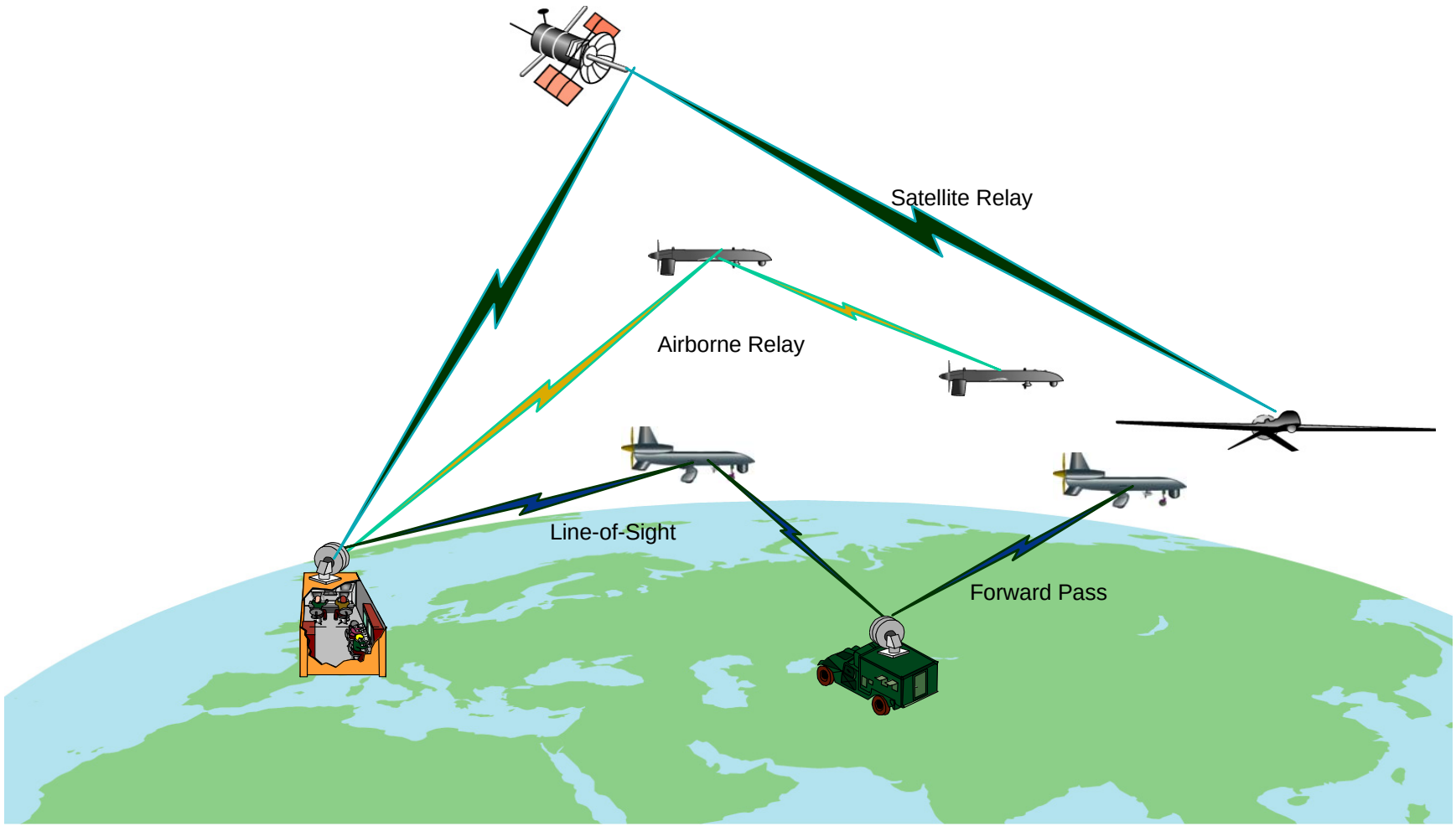
USAF Weather Scout UAV Demonstration

Aerosonde



Ground Infrastructure for ROA

ROA Data Link Options



Where ROAs Can Possibly Support NOAA Requirements

- **Global Observing and Atmospheric Research:** ROAs can provide detailed vertical profiles of the atmosphere and ocean at a large number of fixed points over the globe.
- **Fisheries Enforcement:** NOAA fisheries enforcement encompasses the entire 3.4 million square miles of the Exclusive Economic Zone.
- **Hurricane Tracking & Research:** G-IV is limited to around 45,000'. A ROA capable of 60-80,000' would give this capability for dropsonde delivery to over almost all hurricanes, stay on station longer, and not risk an aircrew.

Where ROA's Can Possibly Support NOAA Requirements (cont)

- **<u>Charting and Mapping</u>:** Charting the near-shore of the 3.4 million square miles and remote areas (i.e. NWHI).
- **<u>Ecosystem/Habitat/Marine Mammal Support:</u>**
  - Coral Reef mapping: The ability to support spectrally robust sensors in remote areas for sustained periods.
  - Marine Mammal mapping: A non-obtrusive instrument for identifying, tracking, and sighting of marine mammals.
  - National Marine Sanctuaries: ROAs may have numerous applications for conservation science and enforcement especially in remote areas.

What's been happening recently

- NASA / NOAA / GA-ASI Demo with Altair
  Palmdale, CA – April to August '05
- NASA UAV Civil Assessment Workshop
  Akron, OH – April '05
- Unmanned Aerial Vehicles Annual Conference
  San Diego, MD – May '05
- RTCA Special Committee 203
  Annapolis, MD – June '05
- Association of Unmanned Vehicle Systems International (AUVSI) – "Grand-daddy of them all"
  Baltimore, MD – June '05

NOAA Remotely Operated Aircraft Flight Demonstration Spring/Summer 2005

Mike Aslaksen (NOS) - Project Manager
Sara Summers (OAR) – Deputy Project Manager

Platform: GA-ASI ALTAIR

- The ALTAIR, a high altitude version of the Predator B, was specifically designed as an unmanned platform for both scientific and commercial research missions.
- Built in partnership with NASA, the ALTAIR has an 86 ft wingspan, can fly up to 52,000 ft and can remain airborne for well over 30 hours.
- Marked as the first remotely piloted aircraft that will meet aviation authority requirements for unmanned flights in National Air Space

- Wingspan: 86 ft
- Fuselage:36 ft
- Weight:7,000 lb
- Altitude:52,000 ft
- Endurance:30+ hr
- Payload: Internal - 660 lb
  External - 3,000 lb
- Air Speed: Over 220 kn

Integrated Sensor Package and Operational Goals:

Combined ozone photometer and gas chromatograph instrument

Demonstrate the smallest airborne 2 channel gas chromatograph and it capabilities of measuring up to twelve different trace gases that are important in climate change, stratospheric ozone depletion, and air quality.

Ocean Color and Passive Microwave Vertical Sounder

(1) Determine the capability to calibrate spaceborne ocean color sensors in near-coastal areas. Coastal areas are difficult to observe from space due to the influence of land on the broad footprints of satellites.

(2) Determine the impact of clouds on spaceborne ocean color sensors data. The UAV can fly underneath cloud cover to provide calibrated ocean color data with which to intercompare with satellite sensors.

(3) Determine the capability to detect water vapor jets and quantize their moisture flux prior to landfall. Measurement of moisture flux and structure is key to predicting precipitation and flood potential at landfall.

Airborne Maritime Surveillance Electro Optical/Infrared (EOIR) Gyro Stabilized Imaging Sensor

(1) Determine the capability and cost benefits of a UAV with a Maritime Surveillance EOIR sensor for fishery and marine sanctuary enforcement especially in remote areas.

(2) Determine the capability and cost benefits of a combination Maritime Surveillance EOIR sensor for detecting and positively identifying marine mammals both in the water and on land for habitat and migration research.

(3) Determine the capability and cost benefits of a UAV with a Maritime Surveillance EOIR sensor for determining the location of commercial and recreational fishing vessels for research correlating fish stocks and coral reef damage.

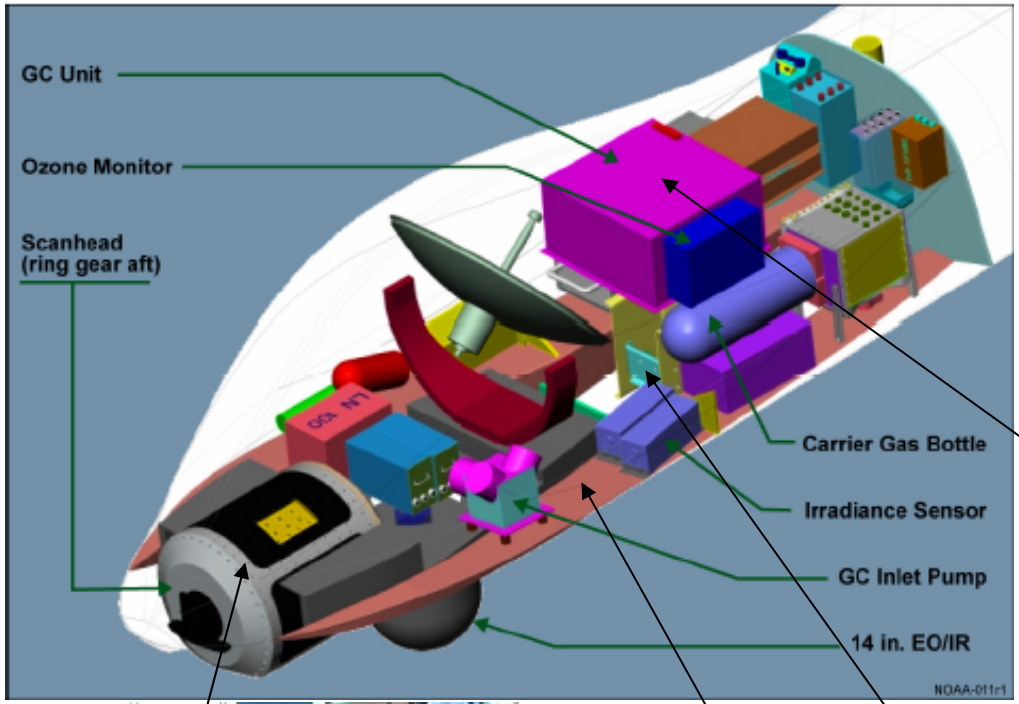
Direct Geo-referenced Digital Camera

(1) Determine the capability and cost benefits of a UAV equipped with a Direct Geo-referenced Digital Camera to gather data to accurately determine and assess the composition of both the marine and terrestrial resources in remote areas.

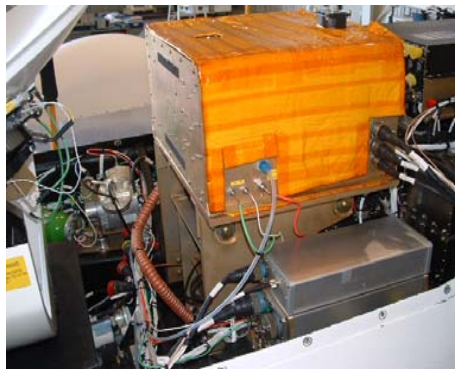
(2) Determine the capability and cost benefits of a UAV equipped with a Direct Geo-referenced Digital Camera to gather data to determine the application for shoreline mapping and near shore bathymetry in remote areas.

Research Environment for Vehicle-Embedded Analysis on Linux (REVEAL) system

The REVEAL system as tested is a flexible “plug & play” sensor acquisition and processing system complete with an internal sensor suite and local area network hardware, and an open standards-based software framework for building dynamically reconfigurable network-centric vehicle- and environmental-monitoring systems.

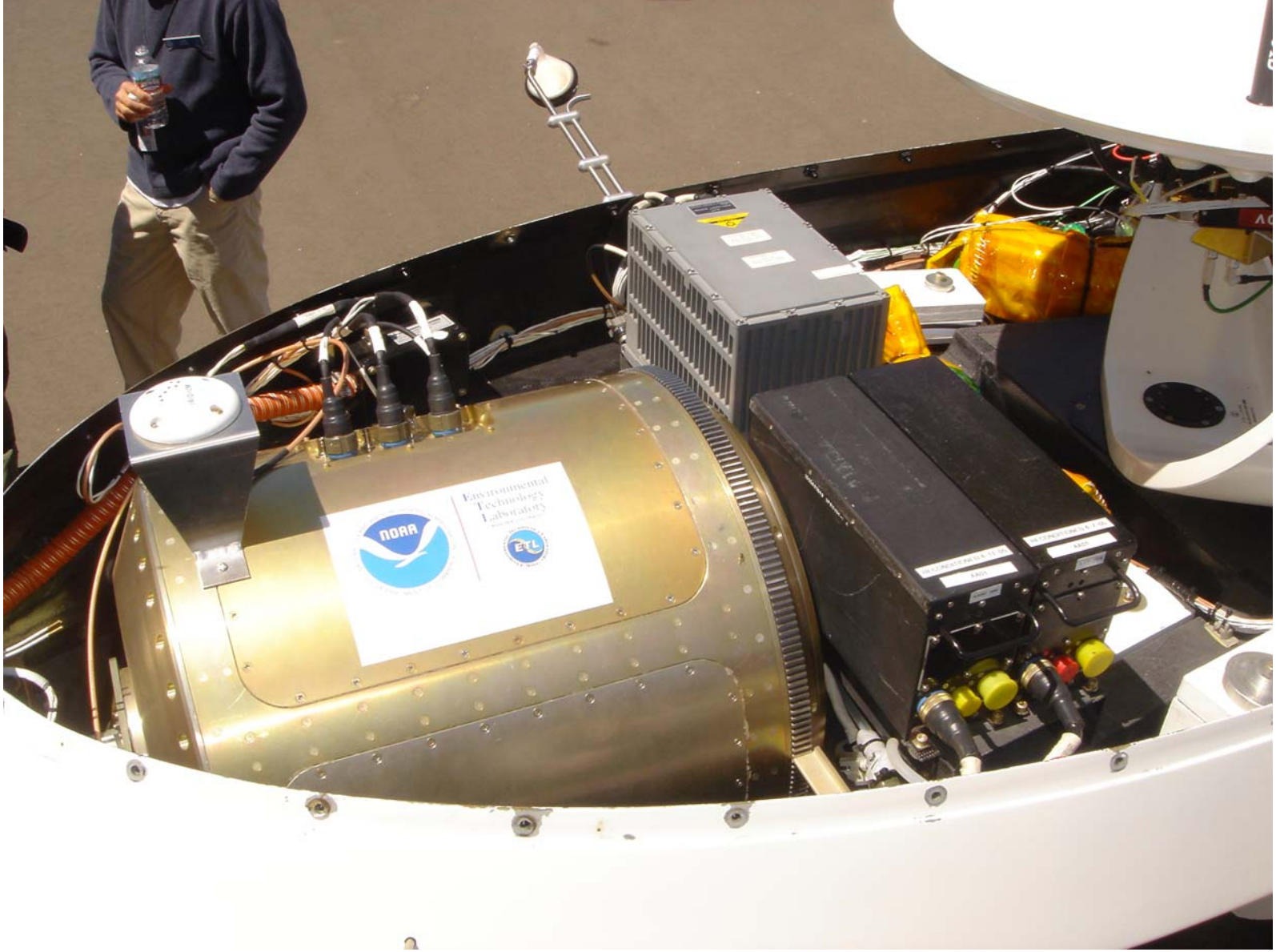


Combined ozone photometer and gas chromatograph instrument



Direct Geo-referenced Digital Camera

Ocean Color and Passive Microwave Vertical Sounder



NOAA instrument package aboard the Altair.

ALTAIR Mission Flights – Spring 2005

Flight Key of Example Flights

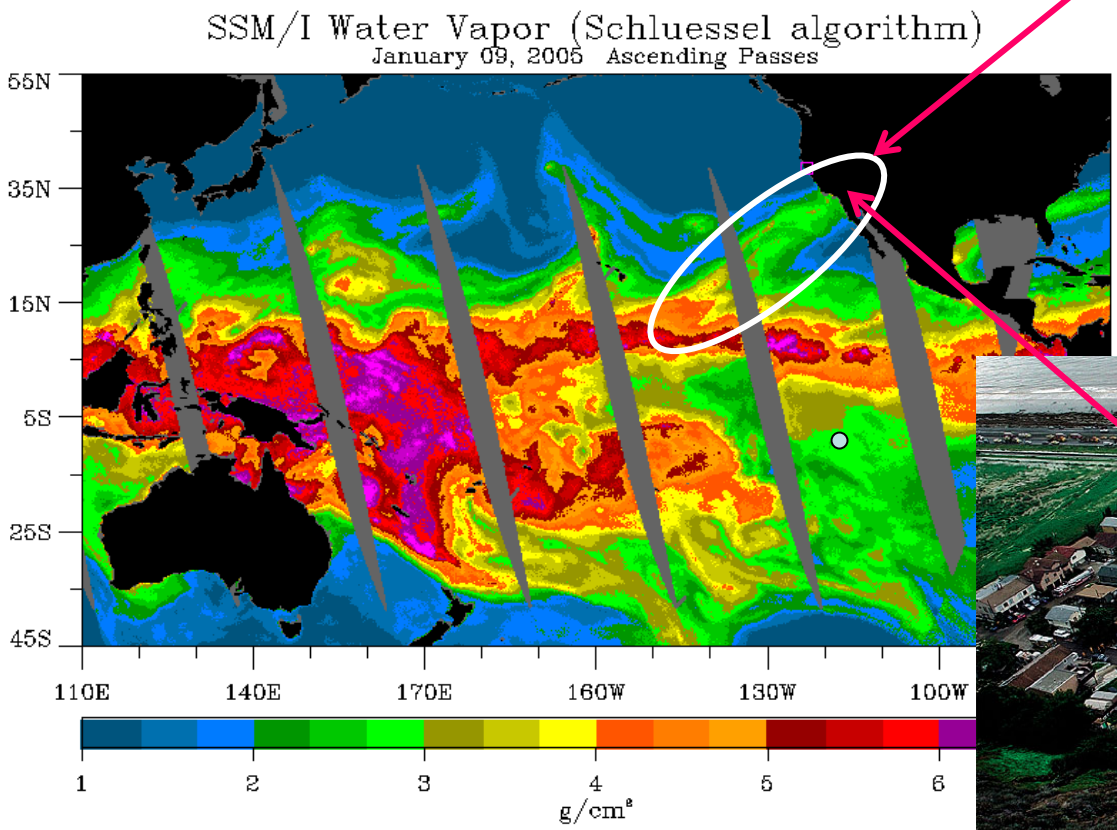
Red – Test Flights from El Mirage

Blue – 6 Hour Flight (Channel Islands)

Yellow – 21 Hour Flight (North Pacific)

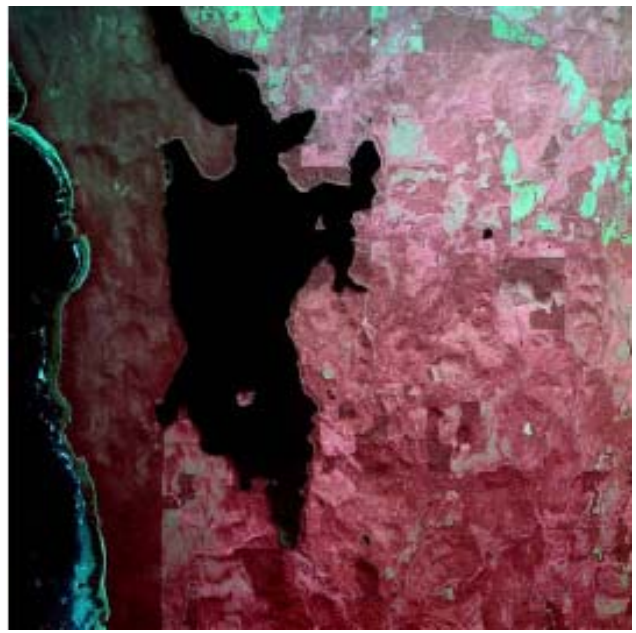
SSM/I satellite observations of water vapor indicate atmospheric river conditions contributed to heavy precipitation. Ralph et al. (2004) showed that IPW > 2 cm is an indicator of atmospheric river conditions in this environment. Observations suggest a direct link to tropical water vapor reservoir.

Atmospheric river on 9 Jan 2005



Fatal mudslides and floods on 10 Jan 2005

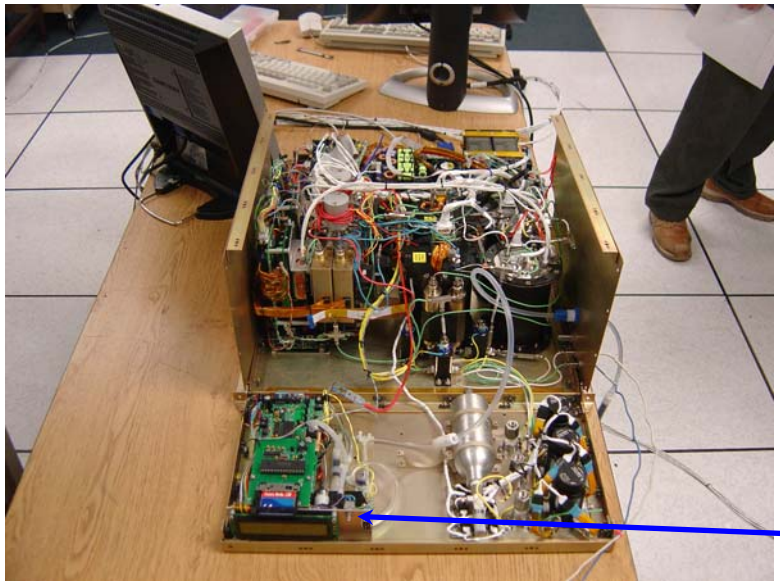
NASA CIRRUS Digital Camera



Assess the composition of both the marine and terrestrial resources in remote areas.

Shoreline mapping and near shore bathymetry in remote areas.

NOAA/CMDL UAV Chromatograph for Atmospheric Trace Species (UCATS)/ Ozone Instrument (OZ)

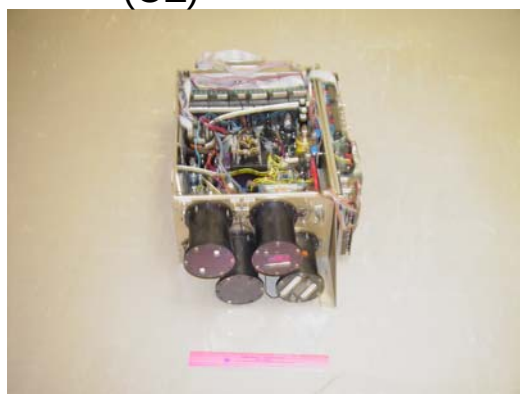


1. **Measures O_3 once every 10 seconds.**
2. **Measures N_2O, SF_6, CFC-11, CFC-12, halon-1211 once every 70 seconds.**

Ozone Instrument (OZ)

<u>Potential uses for GC-OZ mounted on UAV platforms</u>

Climate Change
Stratospheric Ozone Depletion
Air Quality
Atmospheric Chemistry
Transport
Homeland Security

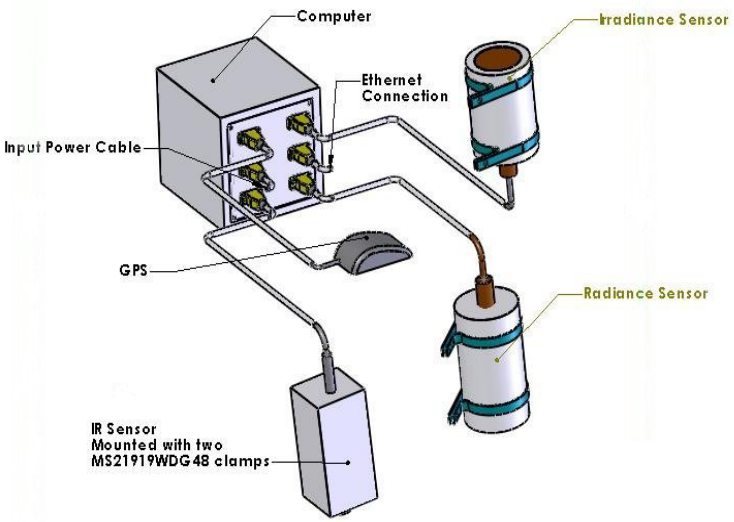


Original CMDL 2 channel Gas Chromato-graph (GC), UCATS is brand new.

NOAA Airborne Ocean Color Mapper Spring 2005

Improves estimates of primary productivity for ecosystem-based management of fisheries.

Improves forecasting and warnings of Harmful Algal Blooms.



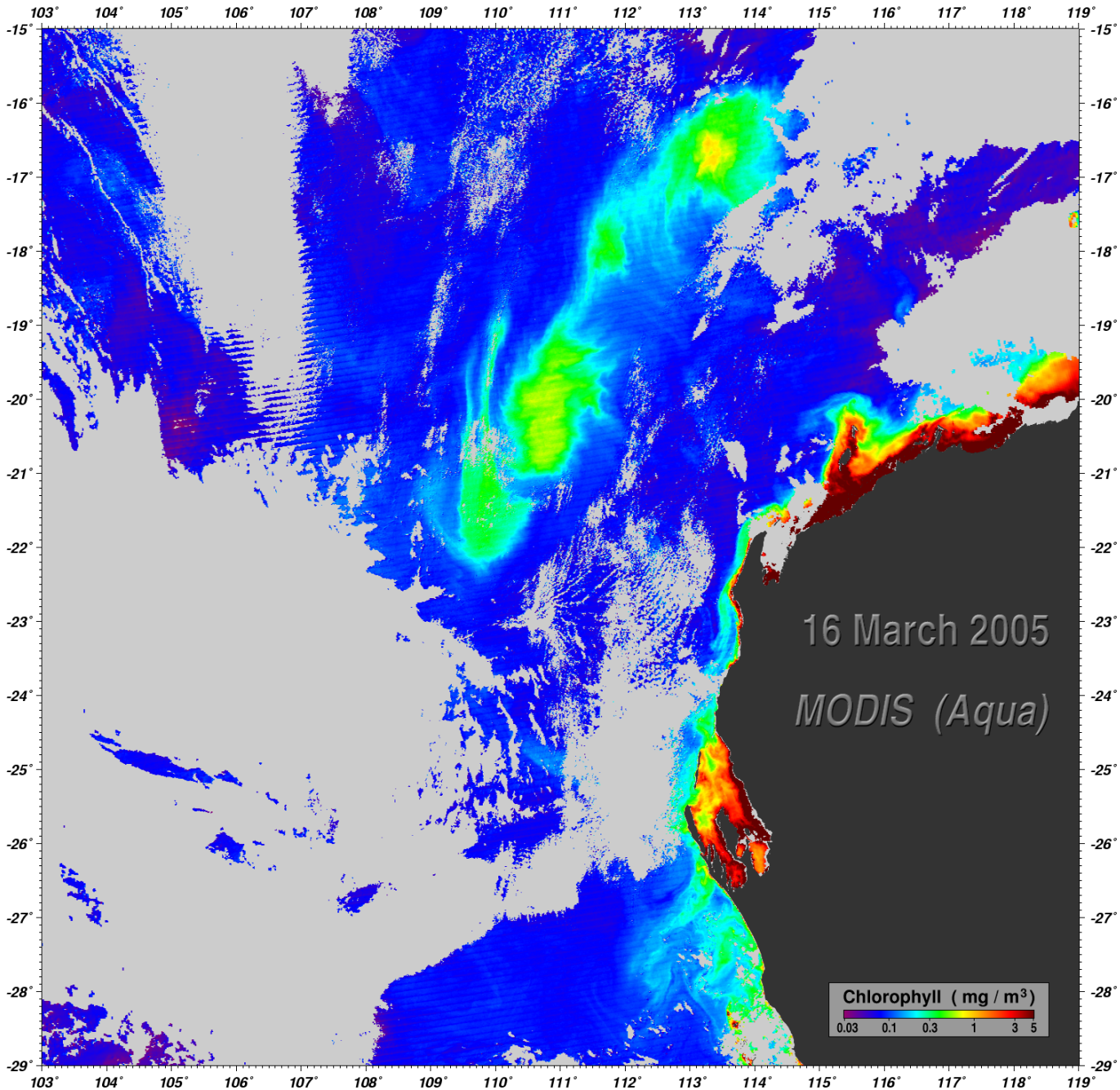
ETL ocean color sensor suite as configured for Altair flights in Spring, 2005.

The OC instrument provides high resolution chloraphyll-a concentration data.

<u>Specifications:</u>
Weight ~20 lbs
Power ~50 Watts

Ocean Color Mapper

Satellite image of chlorophyll concentration off Australia. Gray areas are clouds.



5/4/2005

NOAA Investigates the Utility of ROAs for Atmospheric and Oceanic Research and Science Operations

- NOAA determines objectives, defines requirements sets priorities, establishes success criteria, participates in the demonstration, and evaluates results.
- GA-ASI provides the aircraft, ground systems, performs all operations and maintenance and manages the Demonstration for NOAA.
- GA-ASI leverages significant experience in similar ROA scientific operations for U.S. and foreign governments.
- NASA contributes significant ROA experience to assist NOAA in planning and conducting the Demonstration, sponsors the Certificate of Authorization (COA), and provides safety and operations oversight.
- NOAA, NASA and GA-ASI Team cooperate on planning, execution and share lessons learned.

Demonstration Project Costs

Integration Costs	
NASA Integration Costs	$149,618
NOAA Integration Costs	$591,588
Flight Test & Mission Support	
Pre mission activities	$80,625
Mission Flights (53 hours)	$243,507
Insurance (SATCOM,EOIR)	$55,228
30 day SATCOM Fee	$155,086
SATCOM Equip Fee (Lease)	$178,018
Chase Plane Lease	$31,635
NASA Overheads	$133,530
TOTAL	$1,618,335
Less NASA Integration Costs	**$1,469,217**

Funding Source: $1.3M from ADF with funding and in-kind contributions from across NOAA

Altair Demo Overview

- April 20th - VIP demo and Media Day - VADM Lautenbacher & Scott Rayder present
- May 7th - First successful operational flight - using Digital Camera System (DCS) around Channel Islands NMS
- Approximately 37 of 53 planned hours flown to date
- All NOAA instruments have worked great

Altair Demo Completion

- Ku SPMA satellite datalink card tests needed
- Generator fix with high-altitude brushes
- 8+ hour flight test at 45K’ on Edwards AFB range ~ 7/21 (test Ku SPMA and generator fixes)
- 8-10 hour over-the-horizon open ocean flight ~ 7/25
- “Go / No-go” decision via NASA telecon – 7/29
  - Schedule can slip a week if aircraft not ready
- Instrumentation re-install begins ~ 8/1
- Science flights resume ~ 8/15 (target date)
- 20-hour flight of primary interest, followed by Channel Islands NMS flight

Challenges

- ROAs will need airspace access comparable to manned aircraft
- Very low altitude small ROAs pose real challenges to the FAA and manned operations
- National and International issues of frequency spectrum, standardization and airspace interoperability need to be addressed
- Major technical issues are communications and detect-see-avoid capability
- ROAs are currently weather limited

NOAA ROA's in the PPBES Process

- Currently this group will report to Weather Water Science, Technology & Infusion (ST&I) Program. Program Manager: Dr. Marty Ralph - OAR
- FY07- FY11 PDM – ST&I tasked with conducting NOAA-wide ROA requirements analysis and evaluation and include in FY08 PBA.
- Results of analysis:
  - 26% classified as definite
  - 23% classified as probable
  - Therefore, nearly 50% of NOSA-listed observation requirements can either definitely of probably be measured using ROA's

NOAA ROA's in the PPBES Process (cont.)

- Major applications selected for more detailed requirements analysis:
  - Climate Change Prediction – Persistent Earth Observations
  - Satellite calibration / validation
  - Ecosystems and Endangered Species Monitoring
  - Atmospheric, Climate and Ocean Research
  - Coastal and Coral Mapping
  - Weather Prediction
  - Surveillance for Homeland Security, Fisheries and Marine Sanctuaries Enforcement
- Funding for the next three FY's
  - FY06, $0
  - FY07, $2.55M "above core"
  - FY08, $5.75M "above core"

Where are we in the near term?

- Finish Altair Demonstration – August ‘05
- Develop NOAA lessons learned and evaluate NASA lessons learned from demo – late August ’05 or early September ‘05
- Hold bi-weekly or monthly ROA Working Group telecons
- Presentation to Science Advisory Board on August 9th in Seattle (Dr. MacDonald)

Where do we want to go next?

- Spring ’06 project on Altair in conjunction with NASA – NW Hawaiian Islands? (Funding and Altair Demo outcome dependent)
- NASA Global Hawk Air Vehicle-1 (AV-1). Likely acquisition Spring/Summer ’06. Monthly telecon’s with NASA Dryden
- Observe USAF Weather Scout Aerosonde demo – August-November ’05 (Aug 8-12th @ Wallops – volunteer?)
- Continue to build interagency partnerships, i.e., NOAA/NASA/DOE/NSF - Nov ’05 workshop
- Navy CIRPAS (Monterey, CA) – 2 Predator A’s

Responsibilities of this group

- Change NOAA terminology to Unmanned Aircraft System (UAS) and Unmanned Aircraft (UA) – FAA and DoD standard term???
- Develop a NOAA UAS Charter for this group (mimic AUV program – Justin Manley)
- Brief NOAA leadership on successes / challenges of Altair Demo
- Determine funding within the PPBES process and coordinate future UAS demonstrations
- Continue to build relationships with other government agencies – Sara Summers will lead
- Continue to work with RTCA SC203 and Access 5 to gain routine same day “file & fly” access to National Airspace System (NAS)

Responsibilities of this group (cont.)

- Develop Senate Committee Report, in conjunction with NASA, “on the potential use of UAV’s to operate in the near space environment for a variety of scientific and operational missions” (by 3/17/2006)
- Monitor NOAA evolving requirements and determine if UAS’s can fill critical gaps in observing systems
- Develop a NOAA UAS “Roadmap” (similar to DoD)
- Make recommendations to NOAA leadership on whether to own, lease or rent a UAS. Develop Cost and Operational Effectiveness Analysis (COEA) in conjunction with NASA – including safety concerns
- Brief various NOAA Councils
- Continue to use and develop NOAA UAS website

Working Group Tasks

- Refine Purpose and Mission statements
- Develop NOAA ROA Working Group Charter and obtain signatures from Steering Committee Co-Chairs
- Keep apprised of Altair Demo Completion (Sara Summers lead)
- Start planning next mission on Altair – tbd
- Update group on status of NASA's Global Hawk acquisition (Harris)
- Volunteer for USAF Aerosonde flights – August 8-12th at Wallops, VA
- Concerns or ideas to Sara or myself
- Next telecon – week of August 8th?

Questions?
http://uav.noaa.gov